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THE ATOMIC BOMB TEST OF JULY 16, 1945. J. H.
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THE DISTRIBUTION OF FISSION PRODUCTS IN THE SOILS OF CENTRAL
AND NORTHEASTERN NEW MEXICO AS A RESULT OF
THE ATOMIC BOMB TEST OF JULY 16, 1945

by

J. N. Chubb, K. E. Larson, K. H. Larson

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ABSTRACT

Soils and plants from the area of central and northeastern New Mexico, which was contaminated by fall-out from the atomic bomb detonation of July 16, 1945, were analyzed for plutonium. Plutonium was found in amounts up to 0.07 micrograms per square foot of soil, one-half inch deep, at a distance of 88 miles northeast of the site of detonation. A maximum of 1.87 micrograms per square foot, one-half inch deep, was found on the Chupadera Mesa at a distance of 28 miles northeast of the detonation site. No plutonium was found in samples collected 3 miles south of the site.

In assaying for plutonium, the method of Eisenacher was adapted to soil and plant samples. An estimated precision of ± 15 per cent was obtained when the method was applied to field samples. A recovery of 90.0 ± 3.0 per cent was obtained when the method was applied to a "standard" soil. Uranium and thorium do not interfere in this method even when they are present in quantities much greater than the maximum amounts normally found in soils.

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THE DISTRIBUTION OF PLUTONIUM IN THE SOILS OF CENTRAL
AND NORTHEASTERN NEW MEXICO AS A RESULT OF
THE ATOMIC BOMB TEST OF JULY 16, 1945

The fate of radioactive residues released into the environment have been under serious consideration since the first nuclear detonations which occurred in New Mexico on July 16, 1945 (1, 7). In order to document the fate and persistence of radioactive fall-out originating from a nuclear detonation, a radiological survey of the Alamogordo area that was contaminated was begun in August, 1947. Since 1947, periodic surveys of the area were made up to 1956. This report presents a summary of the data obtained by this laboratory on the plutonium content of soil and plant samples collected in the area. Some of these data have been issued earlier in a preliminary report (6).

EXPERIMENTAL PROCEDURE

In determining plutonium the method of Eisenacher (2), which was developed to isolate minute amounts of plutonium from urine and other biological materials, was adapted to the analysis of soils and plants. Soil samples are prepared for analysis by wet ashing first with concentrated nitric acid and then with 70 per cent perchloric acid followed by the conversion of the residue to soluble fluorides by treatment with 48 per cent hydrofluoric acid. In this form they may be assayed for plutonium. Plant ash samples are processed in the same manner as soil samples. The detailed procedure is presented below.

Reagents:

- (1) Nitric acid. Concentrated, reagent grade, 68 per cent.
- (2) Perchloric acid. Reagent grade, 70 per cent.

- (3) Hydrofluoric acid. Reagent grade, 48 per cent.
- (4) Nitric acid - hydroxylamine hydrochloride solution. Dissolve 6.95 g hydroxylamine hydrochloride in approximately 800 ml distilled water, add 130 ml concentrated nitric acid and adjust volume to 1 liter.
- (5) Lanthanum nitrate solution. Dissolve 2 g of $\text{La}(\text{NO}_3)_3 \cdot 6 \text{H}_2\text{O}$ in 100 ml of distilled water.
- (6) Hydrofluoric acid, 12 N. To 570 ml of distilled water in a polyethylene container, add 430 ml of 48 per cent HF.
- (7) Hydrofluoric acid, 1.5 N. To 945 ml of distilled water in a polyethylene container, add 55 ml of 48 per cent HF.
- (8) Aluminum nitrate solution. Dissolve 1360 g reagent grade $\text{Al}(\text{NO}_3)_3 \cdot 9 \text{H}_2\text{O}$ plus 25 ml of concentrated HNO_3 in distilled water and dilute to 2 liters.
- (9) Sodium nitrite solution. Dissolve 12 g of reagent grade NaNO_2 in 100 ml of distilled water. Prepare just before using.
- (10) Trichlorofluoroacetone (TTA) solution. Dissolve 25 g of TTA in 500 ml of benzene.
- (11) Nitric acid, 8 N. Dilute 520 ml of concentrated HNO_3 to 1 liter with distilled water.

Extraction Procedure:

- (1) To 1 g of oven-dried soil (250 microns diameter and less) in a 75 ml platinum evaporating dish, add 5 ml of concentrated nitric acid and evaporate to dryness on a steam bath.
- (2) Add 5 ml of 70 per cent perchloric acid, stir to break up particles and evaporate to dryness on a hot plate.
- (3) Add 15 ml of 48 per cent hydrofluoric acid, stir to break up particles and evaporate to dryness on the steam bath.
- (4) Add 10 ml of 8 N nitric acid and 10 ml of 12 N hydrofluoric acid solution, stir to break up particles and evaporate to dryness on the steam bath.

(5) Transfer the clear liquid to a 150 ml beaker leaving any solid matter in the platinum dish.

(6) Add an additional 50 ml of the nitric acid-hydroxylamine hydrochloride solution to the platinum dish and again heat to 75° C before transferring the clear solution to the beaker.

(7) Cover the beaker with a watch glass and allow to stand overnight.

(8) Divide the solution equally into two 80-ml Lusteroid centrifuge tubes. Add 2 ml of lanthanum nitrate solution and 10 ml of 12 M hydrofluoric acid to each tube. Stir and centrifuge at 2500 rpm for 10 minutes.

(9) Discard the clear supernatant liquid. Break up the precipitate with a stirring rod, add 15 ml of 1.5 M hydrofluoric acid and centrifuge again.

(10) Discard the supernatant liquid. Break up the precipitate in each of the centrifuge tubes with a glass stirring rod. Add a total of 25 ml of aluminum nitrate solution to each centrifuge tube at the rate of 3 to 4 drops per addition. Stir with glass rod after adding each aliquot until the precipitate has dissolved completely, and quantitatively transfer the 2 fractions to a 125 ml glass stoppered separatory funnel by using the remainder of the aluminum nitrate solution.

(11) Add 0.25 ml of freshly prepared sodium nitrite solution to the solution in separatory funnel, stopper, shake, and let stand 15 minutes.

(12) Add 10 ml of thionyltrifluoroacetone (TTA) solution and shake on a mechanical shaker for 15 minutes.

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(13) Allow the 2 phases to separate completely. Carefully draw off and discard the lower aqueous phase.

(14) Wash the benzene phase in the separatory funnel twice with 35 ml of distilled water with 1 minute shaking after each addition. Allow the 2 phases to separate cleanly before carefully drawing off the washings. Discard the washings.

(15) Add 10 ml 8 M nitric acid to the washed benzene phase in the separatory funnel and shake for 15 minutes on a mechanical shaker.

(16) Allow the 2 phases to separate completely (10 to 15 minutes). Draw off the acid phase 4 ml at a time into a stainless steel counting planchet and evaporate to dryness at approximately 70° C on a low temperature hot plate. In the transfer of the acid phase, care should be exercised to avoid the passage of the TTA solution into the planchet.

(17) When all of the acid phase, except for that amount in the stem of the funnel, has been added to the planchet carefully add 1 - 2 ml of distilled water to the separatory funnel. Allow the two phases to separate cleanly. Transfer the aqueous phase to the counting planchet allowing none of the TTA solution to reach the planchet. Evaporate to dryness.

(18) Using platinum topped crucible tongs carefully heat the planchet just to redness in the open flame of a Meeker burner to remove any volatile matter, cool, and count.

Sample Collection and Preparation: Surface inch, or half-inch samples were collected from approximately 2 square feet of soil and placed in pint metal cans. (See Fig. 1 for locations.) These samples were taken adjacent to grass roots, as well as from surface soil having

no vegetative cover. In the laboratory, the soil samples were oven-dried in the cans overnight at 105° C and then sieved to obtain the less than 250-micron fraction. This particle size fraction was selected, because, in comparing radioactivity with respect to soil particle size, the less than 250-micron fraction was the most consistent (1). Two 1 g portions of the less than 250-micron fraction were taken for plutonium assay.

Plant samples consisted of grass (6 - 8 weeks old) and tips of juniper and piñon pine trees. Grass sampling was restricted to one species in order to eliminate species differences in mineral uptake. In every case, vegetation that was observed to have a minimum of dust on the leaves was collected. All grass and tree branch tips were washed in tap water, and then in distilled water. The grass samples were oven-dried at 70° C. After washing, the branch tips from trees were separated into needles, bark and the present year's growth, and dead wood. The parts from each tree sample were then dried in a vacuum oven at 50° C. All plant samples were ground in a Wiley mill to pass through a 40-mesh screen and ashed prior to analysis.

Counting Procedure and Interpretation of Counting Data: All samples were counted for 4 hours in alpha scintillation counters employing RCA-5819 end-window photomultiplier tubes and scintillating screens of powdered zinc-cadmium sulfide on Scotch tape (9). Counting geometries ranged between 18 and 23 per cent while instrument background values ranged from 4 to 10 counts per hour. Standard counting errors, calculated by the method of Jarrett (5) were less than 5 per cent for the "standard" soil, which was a mixed desert soil artificially contaminated with plutonium at the rate of 14.3 d/m/g, and less than 10 per cent for

soils from the Alamogordo area containing plutonium in amounts from 3 to 80 d/m/g.

RESULTS AND DISCUSSION

Evaluation of Extraction Procedure: In addition to the instrument background, there was observed a small number of counts associated with the reagents and uncontaminated or control soil. TABLE I gives an estimate of the magnitude of the "background" values obtained. Yolo soil, collected from an experimental plot of the University of California at Davis, California, was chosen as most nearly representing the Chupadera Mesa soils in New Mexico while the mixed desert soil was chosen as most nearly representing the desert soils from the Trinity region. As indicated above, the mixed desert soil contaminated with a known amount of plutonium was chosen as the "standard" soil. The alpha activity from the reagents was the major contributor to the "background" values of the soils. The source of the alpha activity found in reagent blanks has been identified by Healy (4) as actinium and protactinium contaminating the lanthanum nitrate. This was confirmed when purified lanthanum nitrate reduced the alpha activity extracted from uncontaminated Mixed Desert and Yolo soils to 0.20 ± 0.08 d/m/g. No attempt was made to purify the lanthanum nitrate used during the course of the assay of Alamogordo soils. The average background value of 1.2 d/m/g observed for the Mixed Desert soil (TABLE I) was subtracted from the results on the plutonium contaminated "standard" soil used to evaluate the extraction method.

TABLE I

Alpha Activity Obtained from Reagents and Uncontaminated Soils
by the TTA Method and the Bismuth Phosphate Method

Sample	Reagents	TTA Method		Bismuth Phosphate Method	
		Mixed Desert Soil	Yolo Soil	Mixed Desert Soil	
Disintegrations/Minute					
1	0.73	1.14	1.34	1.2	11.3
2	0.85	1.36	1.26	1.1	6.9
3	0.86	1.36	0.99	—	12.4
4	1.06	1.01	1.34	—	10.7
5	0.59	1.62	1.66	—	6.2
6	1.24	1.60	2.04	—	12.1
7	0.64	1.32	1.52	—	—
8	0.64	1.17	—	—	—
Mean + Standard Deviation					
	0.82 ± 0.23	1.23 ± 0.22	1.45 ± 0.33	—	9.9 ± 2.7

To further check the "background" value for soil, the method of Farabee (3) modified (10) to include single bismuth phosphate and lanthanum fluoride precipitations, was applied to the uncontaminated Mixed Desert soil after its conversion to soluble fluorides. By this method, the amount of alpha emitters found was about 8 times greater than that found by the TTA method (TABLE I). Apparently, the TTA method did not extract certain alpha emitting components of the soil.

Since small amounts of uranium and thorium are known to be present in rocks, the recovery of these elements by the TTA method was investigated. Based on the data presented by Rankama and Sahama (8), the maximum amounts of uranium and thorium likely to be present in one gram of soil are 0.00514 mg and 0.140 mg, respectively. TABLE II shows that significant amounts of thorium were extracted only after adding as the

nitrate 150 times the maximum amount expected to be present in soil. Uranium was not extracted even after the addition as nitrate of 500 times the amount expected in soil. Thus, at least part of the high "background" value obtained by the modified Farabee method appeared to be uranium and/or thorium. Furthermore, it may be concluded that uranium and thorium do not interfere in the assay of soil for plutonium by the TTA method.

TABLE II

Extraction of Uranium and Thorium from
Mixed Desert Soil by the TTA Method

Amount of Uranium or Thorium Added (mg/g/Soil)	Amount Extracted (d/m/g)	Per cent Uranium or Thorium Recovered
0.257 Uranium	0.0	0.0
2.33 Thorium	6.1	1.1
0.00514 Uranium	0.0	0.0
0.0140 Thorium	0.0	0.0

TABLE III shows the recovery of plutonium from the "standard" soil. The plutonium added (14.3 d/m/g soil) has, in each case, been quantitatively extracted. Columns 3 and 4 show the additional variable introduced in field samples by the sampling techniques. Since little is known about the physical character of the "fall-out" from the Trinity detonation it is difficult to estimate the original number and size of "fall-out" particles per square foot of surface soil. One or 2 particles difference may account for extreme variations in samples (factors of 2 have been encountered between one gram duplicate samples).

TABLE III

The Recovery of Plutonium from "Standard" and Field Soils

Replicate	"Standard" Soil*	a Series #23 Soil	1947 AE-3 Soil
disintegrations/minute/gram			
1	14.7	4.78	77.3
2	13.4	6.63	75.0
3	14.3	3.99	104.8
4	14.0	3.23	75.5
5	15.6	4.44	88.6
6	14.2	4.29	104.6
7	14.3	3.59	78.9
8	14.0	4.01	80.9
Mean + Standard Deviation	14.3 ± 0.6	4.37 ± 1.03	85.7 ± 12.5

*Approximately 100 aliquots of the "standard" soil were analyzed and all data fall in the range shown above.

TABLE IV

Alpha Activity in 4 - 5-Inch Depth Soil Samples
Collected in 1950

Location	Soil Depth (Inches)	Activity (d/m/g)
AE-1	4 - 5	1.3
AE-2	4 - 5	1.0
P 21-B	4 - 5	0.7
P 21-C	4 - 5	0.9
P 20	4 - 5	0.9
H.G. 0.0	4 - 5	1.3
#14	4 - 5	0.6
#17	4 - 5	0.7
#22	4 - 5	0.7
#24	4 - 5	0.7
#29	4 - 5	0.8
#36	4 - 5	0.8
Mean + Standard Deviation		0.9 ± 0.2

Consideration of the data accumulated on soil collected 4 to 5 inches below the surface of mesa and mesa-like soils (TABLE IV) resulted in the establishment of 1.1 d/m/g (mean plus 1 standard deviation) as a realistic background value for these soils. This value was subtracted from the results of all assays on soils of this type.

The Distribution of Plutonium in the Soil Contaminated by Fall-out Debris from the Trinity Detonation: Samples of "Trinitite", the fused glass-like material, from within the fenced area at Trinity Site and several glass beads found near the fence and along the line of drift of the cloud (see Report UCLA-32 (1) for locations) were assayed for plutonium. The data are presented in TABLE V.

TABLE V

Plutonium Content of Trinitite and Glass Beads from the Fenced Area, along the Four Principle Transects Established in 1947

Sample	Location (ft)	Pu Content of Material (d/m/g)	Micrograms Pu239/g of Material
Trinitite	T90 - 200	9.05×10^3	4.1 66.3 $\times 10^{-3}$
Trinitite	T90 - 600	3.52×10^3	1.6 25.8 $\times 10^{-3}$
Trinitite	T90 - 1,000	3.22×10^3	1.5 23.6 $\times 10^{-3}$
Trinitite	T270 - 200	55.7×10^3	25 408. $\times 10^{-3}$
Trinitite	T270 - 600	9.24×10^3	4.2 67.6 $\times 10^{-3}$
Trinitite	T270 - 1,000	17.1×10^3	7.7 125. $\times 10^{-3}$
10238 g Glass beads, black	Inside fence	$322. \times 10^3$	145 2,360. $\times 10^{-3}$
10284 g Glass beads, black	Inside fence	$528. \times 10^3$	238 3,860. $\times 10^{-3}$
10062 g Glass beads, green	Inside fence	$284. \times 10^3$	148 2,080. $\times 10^{-3}$
10002 g Glass beads, green	Inside fence	40.6×10^3	16 298. $\times 10^{-3}$

TABLE VI presents data accumulated for the lateral reference points and boundaries established during the radiological survey of the Alamo area in 1948 (1). These data suggest that the area originally contaminated by fall-out from the Trinity detonation was greater than the

1,200 square miles estimated by the 1948 survey. Data of TABLE VII on the Harvey Gate series and Lateral 20 present a good estimate of the

TABLE VI

Plutonium Content of Alamogordo Soil, 0 - 1 Inch Depth,
Collected from Various Locations in 1948

Lateral Reference Point*	Distance from Ground Zero (Miles)	Distance and Direction from Reference Point (Miles)	Pu Content of Soil (d/m/g)	Micrograms Pu239/sq ft., 1 Inch Deep	nc./m ²
4	4	6.4	0.0	0.3	7
7	7	11.2	0.0	2.5	54
9	9	14.4	0.0	5.5	125
12	12	19.2	0.0	3.5	79
16	20	32	0.0	2.9	70
16		3.2, left	1.1	0.10	26
16		5.2, right	0.0	0.04	39
18	24	38	0.0	9.1	205
20	28	45	0.0	21.0	482
21	30	48	3.0, left	2.8	70
21		7.2, right	0.4	0.10	20
22	32	51	0.0	24.0	548
22		3.8, left	0.8	0.83	20
22		6.9, right	0.0	0.03	33
23	34	54	0.0	8.5	0
23		4.3, left	1.8	0.00	190
23		6.6, right	1.7	0.29	40
				0.06	53

*See map in UCLA-32 (1) for locations.

plutonium content of a small section of the Chupadera Mesa. An area of about 1 square mile was estimated to average 0.83 microgram of plutonium per square foot 1 inch deep. Similarly, the profiles of Area 21 (1, 4, 7, and 13 located on the south slope, and A, B, and C located on the valley floor) establish the average contamination of this area at 0.91 micrograms per square foot 1-inch deep. The relatively slight change in plutonium level from 1948 to 1956 in these locations indicates that no

TABLE VII

A Comparison of the Plutonium Content of Surface Soil* Collected at Various Locations on the Chupadera Mesa during August, 1947-1956

Location	Year	Pu Content of Soil (d/m/g) $\mu\text{Ci/g}$	Micrograms Pu239/sq ft Soil	nCi/m ²
Area 21, Profile A	1950	25.	0.87	570
	1951	29.	1.00	660
B	1950	47.	1.63	1076
	1951	4.8	0.17	112
	1956	24.	0.83	548
O	1949	25.	0.43*	594
	1950	26.	0.90	594
	1951	11.	0.38	251
1	1950	23.	0.80	528
	1951	23.	0.80	528
4	1950	24.	0.83	548
	1951	34.	1.18	779
7	1950	26.	0.90	594
	1951	30.	1.04	686
13	1950	33.	1.11	752
	1951	27.	0.93	614
Harvey Gate	1948	36.	1.25	
	1950	41.	1.41	
	1951	20.	0.69	
	1956	38.	1.37	
0.2 mi. E. Harvey Gate	1948	18.	0.62	
	1951	39.	1.35	
lateral 20	1950	24.	0.83	
	1951	4.0	0.14	
Ratliff Samples, R-1	1947	55.	0.95*	
	1951	34.	1.18	
R-2	1947	67.	1.20*	
	1951	22.	0.76	
AE-1	1950	6.5	0.22	
	1951	3.0	0.10	
AE-2	1950	22.	0.76	
	1951	12.	0.42	
	1956	20.	0.69	

*These samples were collected from 0 - 1/2 inch; all others were collected from 0 - 1 inch.

appreciable decrease in plutonium content of the soils is occurring due to erosional factors except possibly in barren areas such as represented by the Ratliff samples.

Plutonium was found in soil samples collected as far as 88 miles northeast of Trinity Site (TABLE VIII and Fig. 1) with the maximum contamination occurring on the Chupadera Mesa, 20 to 30 miles north. Analyses were also carried out on soils collected south of Trinity Site from areas running southeast into Mockingbird Pass and west into the Jornada del Muerto from Observation Post B. This series of soil samples all assayed approximately 1 d/m/g, which is considered normal soil background. Further, since the surface soil and 4 - 5 inch profile samples all assayed the same, it was concluded that this area was free of plutonium contamination.

The results of the assay for plutonium of soil profiles collected in 1951 are shown in TABLE IX. Downward movement of plutonium was found in only the two cases where the surface contamination was relatively high. This was also found to be the case in 1949 and 1950 for fission product isotopes (7).

Plutonium Content of Plant Materials Collected in the Alamogordo Area: Several samples of juniper and piñon pine trees from the Chupadera Mesa collected in 1951 were analyzed for plutonium. The data are presented in TABLE I. Although the cortex or bark data are suggestive of possible uptake of plutonium by the trees, via the roots, these data are inconclusive. The fact that soil activity was generally restricted to the surface inch of the profile coupled with negligible activity of wood suggests that external surface contamination was the source of the

TABLE VIII

Plutonium Content of Surface Soil, 0 - 1/2 Inch, Collected at
Various Locations North of the Chupadera Mesa in 1950

Sample Location	Miles from Ground Zero, Trinity Site	Pu Content of Soil (d/m/g)	$\times 2.12$ $\frac{d}{m/g}$	Micrograms Pu239/sq ft., 1/2 in. Deep
1	30	12.	5.41	0.22
2	33	24.	10.81	0.42
3*	36	13.	5.86	0.22
4	40	0.9	.41	0.02
5A	39	4.5	2.03	0.08
6	41	0.8	.36	0.01
7	39	6.0	2.70	0.10
8	43	2.8	1.26	0.05
8A	44	0.5	.23	0.01
9	48	0.8	.36	0.01
10*	52	9.1	4.10	0.16
11	58	1.7	.77	0.03
12	62	0.5	.23	0.01
13	70	0.5	.23	0.01
14	76	0.0	.00	0.00
15	82	0.5	.23	0.01
16	87	1.2	.54	0.02
17*	86	4.5	2.03	0.08
18	82	1.7	.77	0.03
19	90	2.5	1.13	0.04
20	91	1.3	.59	0.02
21	95	0.1	.05	0.00
22	88	4.3	1.94	0.07
23	79	2.5	1.1	0.04
24	76	0.7	.32	0.01
25	72	0.6	.27	0.01
26	68	1.0	.45	0.02
27	65	3.5	1.58	0.06
28	62	1.8	.81	0.03
29	60	0.0	.00	0.00
30	59	1.9	.86	0.03
31	58	0.0	.00	0.00
32	54	0.2	.09	0.00
33	52	0.0	.00	0.00
34	52	1.2	.54	0.02
35	55	6.5	2.93	0.11
36	52	1.6	.72	0.03

*Note: 1956 checks at locations 3, 10 and 17 showed 11., 5.3, and 0.8 d/m/g, respectively.

The results of a limited number of analysis of grass samples from the Chupadera Mesa are given in TABLE XI. Although some of these data are suggestive of plant uptake, they are not conclusive. In view of the soil contamination levels, the observed activities could all be due to external contamination.

TABLE XI

Plutonium Content of Grass Samples from the Chupadera Mesa, 1957 and 1950

Location	Year Collected	Pu Content	
		Plant (d/m/g)	Soil (d/m/g)
AZ-3	1947	40	---
AZ-3	1947	12	---
Ratliff-1	1947	13	55
Ratliff-2	1947	29	67
Harvey Gate	1950	0.5	41
Lateral 20	1950	0.5	24
Area 21, P-1	1950	2.0	23
Area 21, P-4	1950	1.1	24
Area 21, P-7	1950	0.7	26
Area 21, P-13	1950	0.4	33
Area 21, P-B	1950	0.1	47
Area 21, P-C	1950	0.4	26

24
43
01
02
009
05
03
01
002
 $9 \times 10^{-2} (1.4 \times 10^{-2})^2$

SUMMARY

The soils and plants from the area of central and northeastern New Mexico, which were contaminated by the atomic bomb detonation of July 16, 1945, were analyzed for plutonium. Plutonium was found in amounts up to 0.07 micrograms per square foot, one-half inch deep, at a distance of 88 miles northeast of Trinity Site. The greatest concentration of plutonium (1.47 micrograms per square foot, one-half inch deep) was found on the Chupadera Mesa at a distance of 28 miles northeast of Trinity Site. No

measured activity of the bark. The low activity associated with the needles was very likely due to external contamination also.

TABLE IX

Plutonium Content of Soils at Various Depths from the Surface, 1951

Profile	0 - 1"		1 - 2"		2 - 3"		3 - 4"	
	d/m/g	10 ⁻⁵ μ g Pu/g	d/m/g	10 ⁻⁵ μ g Pu/g	d/m/g	10 ⁻⁵ μ g Pu/g	d/m/g	10 ⁻⁵ μ g Pu/g
21 A	28.8 ¹³	21.1	4.4 ²⁰	3.2	0	0	0	0
21 B	4.8 ²¹	3.5	0	0	0	0	0	0
21 C	11.2 ⁵¹	8.2	0	0	0	0	0	0
Harvey Gate	19.8 ⁷	14.5	3.3	2.4	0	0	0	0
lateral 20	4.0 ⁶³	2.9	0	0	0	0	0	0

Note: A check on Profile 21B in 1956 showed 24. and 0.5 d/m/g for the 0 - 1" and 3 - 4" depth increments, respectively.

TABLE X

Plutonium in Needles, Cortex, and Wood from Juniper and Pine from the Chupadera Mesa, New Mexico, Collected August, 1951

(all results are expressed on basis of dry plant material.)

Location	Species	Needles		Cortex		Wood	
		d/m/g	10 ⁻⁵ μ g Pu/g	d/m/g	10 ⁻⁵ μ g Pu/g	d/m/g	10 ⁻⁵ μ g Pu/g
Harvey Gate	Juniper	1.83	1.34	1.07	0.80	0.23	0.17
Area 21, P1	Juniper	0.67	0.49	10.91	8.00	0.07	0.05
Area 21, P4	Juniper	1.14	0.83	4.20	3.07	0.02	0.14
Area 21, P7	Juniper	0.37	0.27	3.60	2.67	0.04	0.03
Area 21, P13	Juniper	1.66	1.20	4.53	3.33	0.02	0.02
Area 21, NS-1	Juniper	1.00	0.74	5.06	3.73	0.05	0.03
Area 21, NS-2	Juniper	0.60	0.43	4.73	3.46	0.05	0.02
Area 21, P1	Pinon	0.34	0.25	1.80	1.33	0.02	0.02
Area 21, P4	Pinon	0.31	0.23	1.80	1.33	---	---
Area 21, NS-1	Pinon	0.12	0.09	0.27	0.19	---	---
Area 21, NS-2	Pinon	0.43	0.31	1.20	0.87	---	---

plutonium was found in soil samples collected 1 mile north of the test. The evidence obtained suggests a minimum of 100,000 curies of plutonium due to the action of erosional factors. A limited survey of analytical plant materials did not show any indication of traces of the effect of plutonium by plants.

In assaying for plutonium, the method of L. S. Brown et al. was adapted to soil and plant samples. An estimated precision of ± 10 per cent was obtained when the method was applied to field samples. A recovery of 98.0 ± 3.0 per cent was obtained when the method was applied to a "standard" soil. Uranium, thorium, or other alpha emitting elements do not interfere in this method even when they are present in quantities much greater than the maximum normally found in soils.

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